THE STAINLESS PRINCE *of* STEELS

THE CHEMICAL FOUNDATION INCORPORATED
654 MADISON AVENUE · NEW YORK, N. Y.

[BLANK PAGE]

THE STAINLESS PRINCE *of* STEELS

PUBLISHED BY

THE CHEMICAL FOUNDATION INCORPORATED

PRINTED IN U. S. A.

THE STAINLESS PRINCE OF STEELS

A GLITTERING NEWCOMER has emerged from the steel industry to tilt its lance at steel's oldest enemy — rust.

Twenty-five years ago an unrealized dream of centuries, as late as 1929 little more than an industrial curiosity, Stainless Steel is today being hailed as the forerunner of a new era in metallurgy and as the leader of the steel industry's now quickening onward march out of depression.

Engineers known for conservatism call it the most important development in steel alloys since introduction of high-speed steels in 1900. And industry, despite the lethargy of recent years, has eagerly accepted it as such and rushed it into so many breaches that veteran steel men lately have been catching their breaths at the all-sweeping pace.

Several years ago when the tide of orders began to mount dizzily, the sales manager for a leading producer set his office staff to work tabulating the uses to which the new alloy was being put. After a short time he threw up his hands. So varied and diverse were the uses and so rapidly did they

multiply that it was impossible to keep track of them. It was like trying to count and classify the raindrops.

Into every industry, into practically every shop in some form or another and into most of the nation's homes — proud and humble alike — has gone this prince of steels, not alone to combat rust but to contribute vitally to some of our most notable industrial advances. The handling of food and especially of milk has been revolutionized by it, and it is blazing a way to an even more spectacular revolution in rail transportation. Our vast new chemical industry, perhaps the greatest American gain growing out of the World War, is dependent upon Stainless Steel in some of its most basic operations. So are the oil, rayon, paper, aviation, and automobile industries, to mention just a few of a lengthening list.

Every new warship that steams to sea is a striking testimonial of the Navy's faith in the new alloy that won't rust, won't tarnish or stain, and which has four to six times the tensile strength of ordinary structural, sheet and plate steels. A single large manufacturer of agricultural equipment and trucks employs Stainless Steel in upward of forty separate applications.

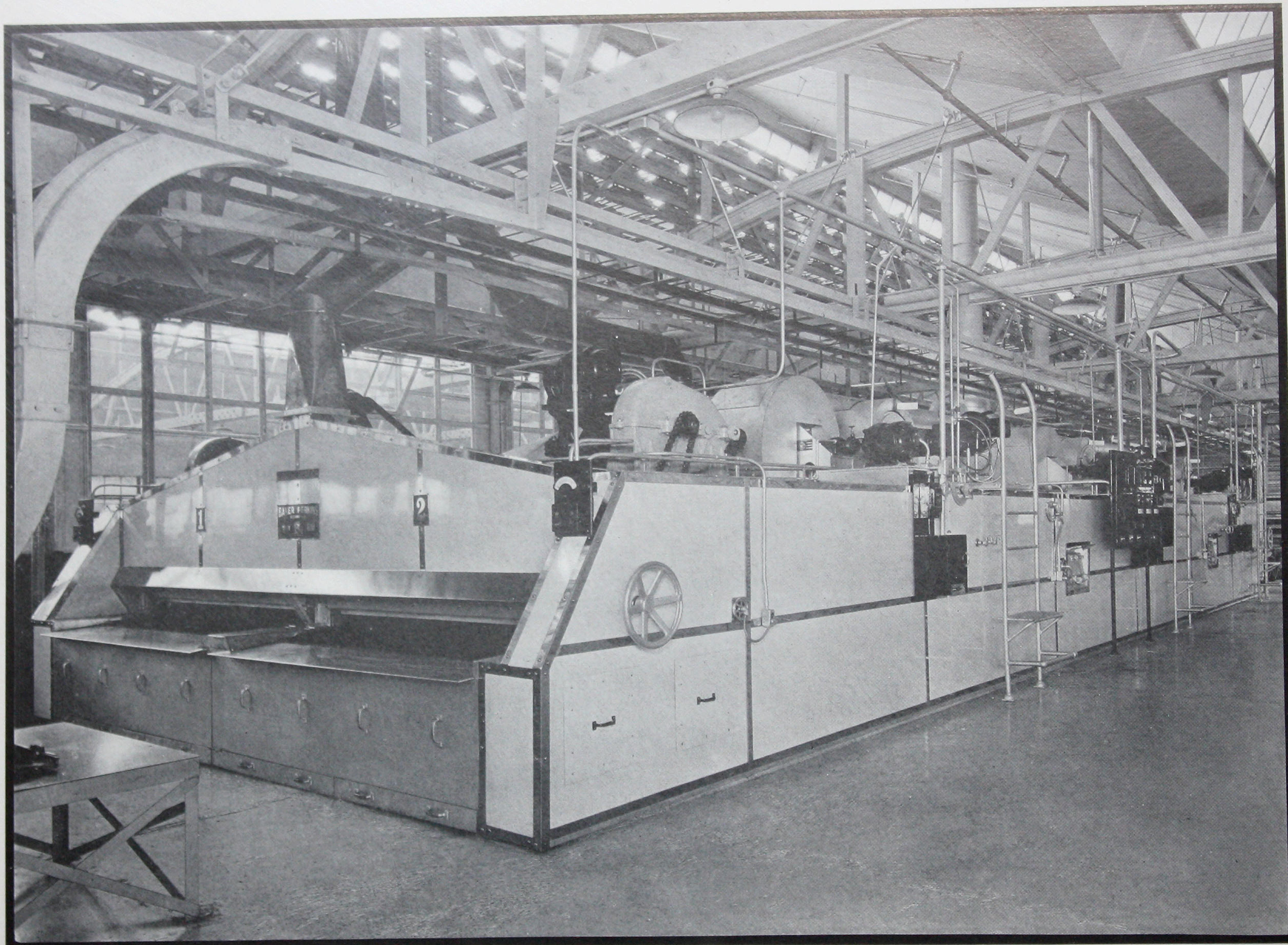
From false teeth to the mighty reaches of Boulder Dam, from mirrors for insane asylums to the gleaming beauty of the Chrysler building's towering spire, from cell locks for jails to the precision instruments of surgeons — such wide extremes point the ever-broadening range of "stainless" in the present-day market. To date the ratio of its successes to failures has been a hundred to one, and these isolated instances of failure have been chiefly the consequence of insufficient testing or of plain misapplication.

As to the future —

It is the opinion of many of steel's most competent observers that in the not too distant future the largest part of our steel output will be in some form of Stainless Steel. A whole new field for exploration has been opened, not only in metallurgy but in industry as well. This wonder of alloys after all is still new. In countless applications it is as yet untried. Public knowledge of its properties is still sketchy. Its first large-scale use came in depression. Its big swing is yet ahead.

In view of these facts, and the already fast expanding market, business and public may well look more closely into Stainless Steel, its history, its forms, and its definitely proven uses up to now. It is doubtful if any other industrial development of recent years contains more striking elements of romance and drama or more intimately affects our national life. In this prince of steels a champion of infinite promise has indeed arisen to conquer.

Elevator Entrance and Doors of 18–8 Chrome-Nickel Stainless Steel.
Hotel Ansonia, New York City.



Delivery end view B-P diathermatic (V.H. type) oil fired oven.

II

As long as iron and steel have been used, what man has built of them has constantly been threatened by rust. Our annual bill payable to this red oxide of iron has been estimated up to three billions of dollars. To cite a single example of rust's toll, Manhattan Bridge in New York City was recently repainted at a cost of $285,000 for labor and $36,000 for paint. Such exposed steel structures must be repainted at least every fourth year and in addition a crew of men must be regularly employed to apply protective coatings where rusting is most prevalent.

Rust is the great destroyer of the Steel Age. It has jeopardized our food by the constant threat of contamination. It has menaced the purity of our chemicals, from which come medicines and dyes. It has stood as a bar to progress in all fields of science.

For centuries it was the goal of metallurgists to produce a steel that would not rust. No other metal than a steel would do, it was found. For example, silver tarnishes; copper and its alloys take on a green oxide coating; copper nickel alloys darken; lead is soft and lacks strength; tin is used only as a coating on steel and may flake off or be pitted through. The plating of steel, while valuable, failed to supply the answer to this major problem.

Imagine then the thrill that shot through the tired brain of the English metallurgist, Brearley, when after years of work he discovered the first rust-resistant steel alloy. It was just before the World War. Brearley was searching for an alloy, to be used in naval guns, that would resist the corrosive effect of sustained fire. He added chromium to his steel and according to common practice tested the alloy first in hot sulphuric and hot hydrochloric acid baths. Then some queer turn prompted him to try a bath of nitric acid. What followed etched the name of Harry Brearley on the steel plate of that day's history.

Certain of Brearley's chromium steel alloys while not immune to the sulphuric and hydrochloric acids were quite immune to the action of the nitric acid!

"Nitric acid — oxidation," the words paired in Brearley's mind. A light dawned as he realized the significance of what he had observed. His hands trembled as he repeated the test with nitric acid to be sure.

Nitric acid is an oxidizing agent, he reasoned. It causes oxygen to combine with the material attacked. So likewise is rust, as occurring in the air and in water, a product of oxidation. Therefore if a chromium steel alloy

would resist nitric acid why wouldn't it also resist rust? More tests, days of anxious waiting, and Brearley got his answer. The new alloy *DID* resist rust!

This experimental work of Brearley was carried on in the great English steel center at Sheffield and naturally the first chromium steels produced were tried out in Sheffield's most famous product, cutlery. A fervent "Thank God!" was sent heavenward by English housewives for the new knives and other utensils that would neither rust nor stain nor tarnish. At last a rustless steel was a fact.

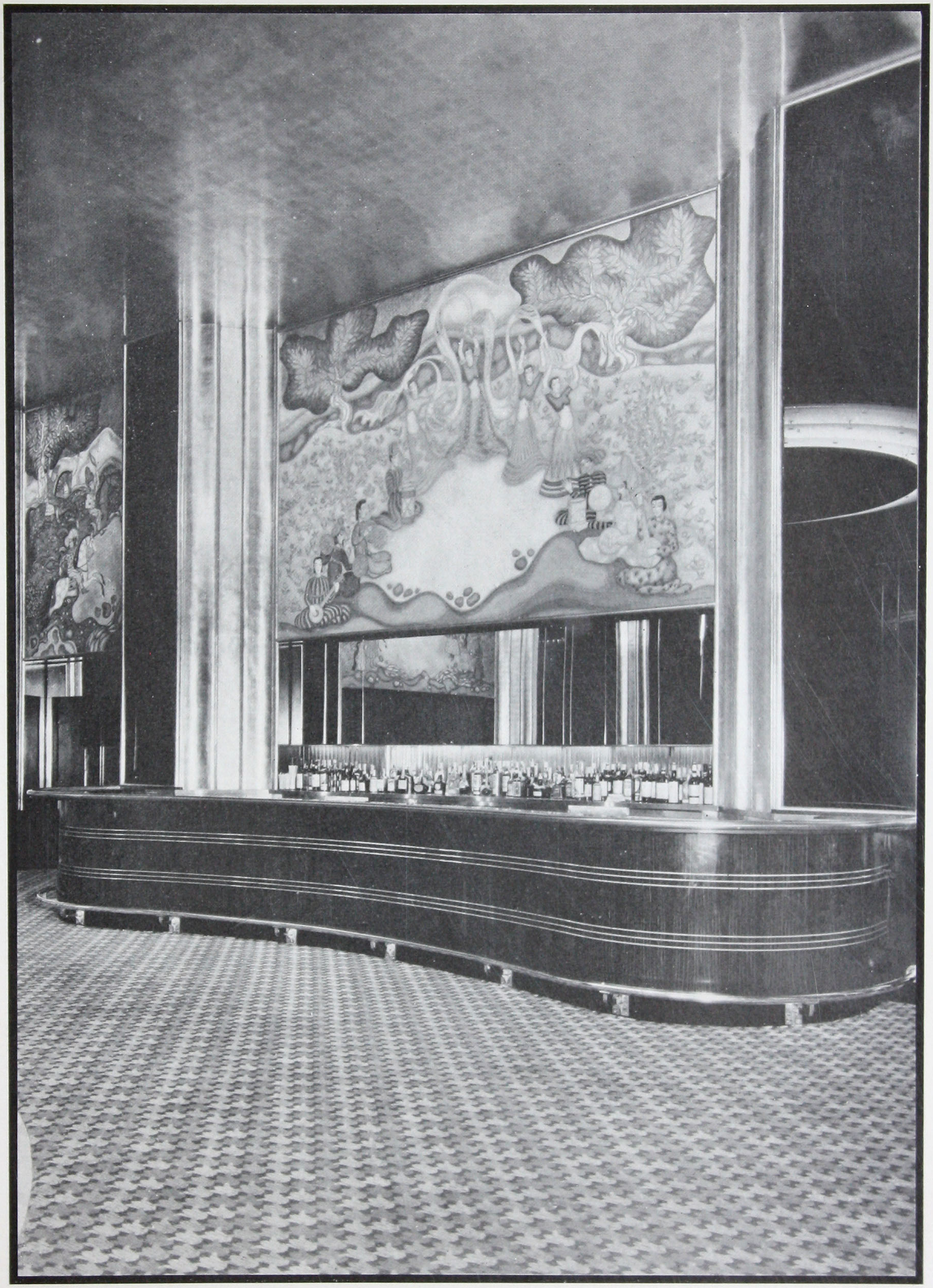
This original cutlery type of steel contained about 12 per cent chromium and about .3 per cent carbon. The same analysis with certain modifications using higher chromium and carbon contents is still the standard for Stainless Steel cutlery. But Brearley's work and that of his associates at Sheffield was only a starting skirmish in the battle against rust, a battle forgotten for a time by the public as the world went to war.

The war interrupted the commercial introduction of "stainless" because chromium was needed for military uses. In Germany, however, Benno Strauss had investigated the combination of chromium and nickel in steel and found that with certain percentages of these alloying elements, such as 18 per cent chromium and 8 per cent nickel, a product was secured that possessed even greater resistance to corrosion than the straight chromium steels of the cutlery type. Moreover, the chromium-nickel steels possessed great ease in workability.

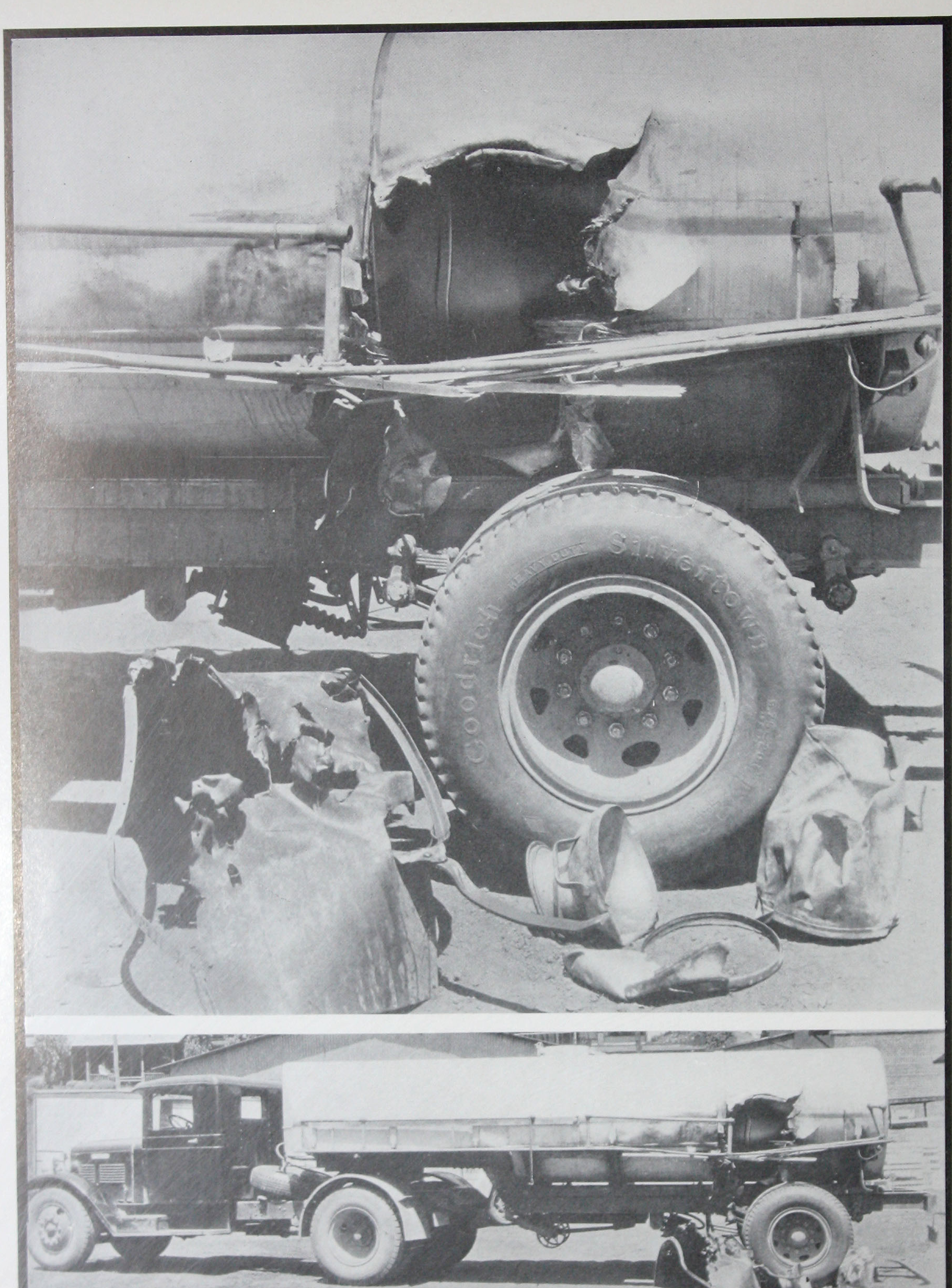
Still later it was found that plain chromium steels containing 16 per cent to 30 per cent chromium and generally a low carbon content were intermediate in their resistance to corrosion between the cutlery type and the chromium-nickel type. These higher chromium steels also possessed splendid working characteristics. And yet more experiment brought out that by reducing the carbon of the cutlery type to about .12 per cent an engineering material was obtained of good resistance to corrosion and easier workability than the cutlery steels. At the same time this newest alloy did not have to be heat treated and polished in order to secure rust resisting properties.

Thus, four general types of Stainless Steel came into being under the deceptive singular name:

(1) Straight chromium cutlery type,
(2) straight chromium hardenable engineering type,
(3) straight chromium non-hardenable type, and
(4) non-hardenable chromium nickel type,



Back counter flashing, wall panels at entrance of bar, two grills, top and side of woodwork. Plaza Hotel bar, New York City.



Stainless Steel milk tank undamaged after dynamite explosion.

all with or without the addition of other special alloying elements. Today one manufacturer alone produces thirty different special types of Stainless Steel, each possessing specific properties from the others. However, the most commonly used and best known type is the so-called "18-8" — the alloy of 18 per cent chromium and 8 per cent nickel.

Now mark one more fact:

Brearley, Strauss and the others sought merely rust resisting steels of good strength. They succeeded beyond their wildest dreams. They got steels of a strength not before known in alloys of this character. Types 1 and 2 of Stainless Steel can be heat treated to produce tensile strength of more than 200,000 pounds per square inch. Types 3 and 4 possess tensile strength of 80,000 to 100,000 pounds per square inch in the annealed condition, and may be cold worked in thin sheets or wire to tensile strengths of 200,000 to 350,000 pounds per square inch.

When these figures are compared with the tensile strength of ordinary structural steels and ordinary sheet and plate steels, which is only 50,000 to 60,000 pounds per square inch, one can readily understand why engineers today are talking of the dawn of a new era in steel.

Not long ago, during a price war in a southern city, a 2000-gallon single compartment Heiloy metal drop frame milk truck was blown up by dynamite, which had been placed in the rear can rack of the metal tank. The explosion tore off the aluminum and cork covering of the tank, smashed a supporting crossbeam, blew out two tires and shattered the cab windows thirty-five feet ahead. To quote the user: "The tank was full of milk at the time. There were no leaks after the explosion occurred and after being reinsulated and covered with aluminum, the truck was again put into service without missing a single trip."

When the debris was cleared away the tank itself was minutely examined. There was a bulge in the side which had received the impact of the explosion but that was all. The welds were tight. The thin metal shell was not so much as cracked. Re-insulated and re-covered with aluminum the tank was put back into service without missing a trip. It was of Stainless Steel.

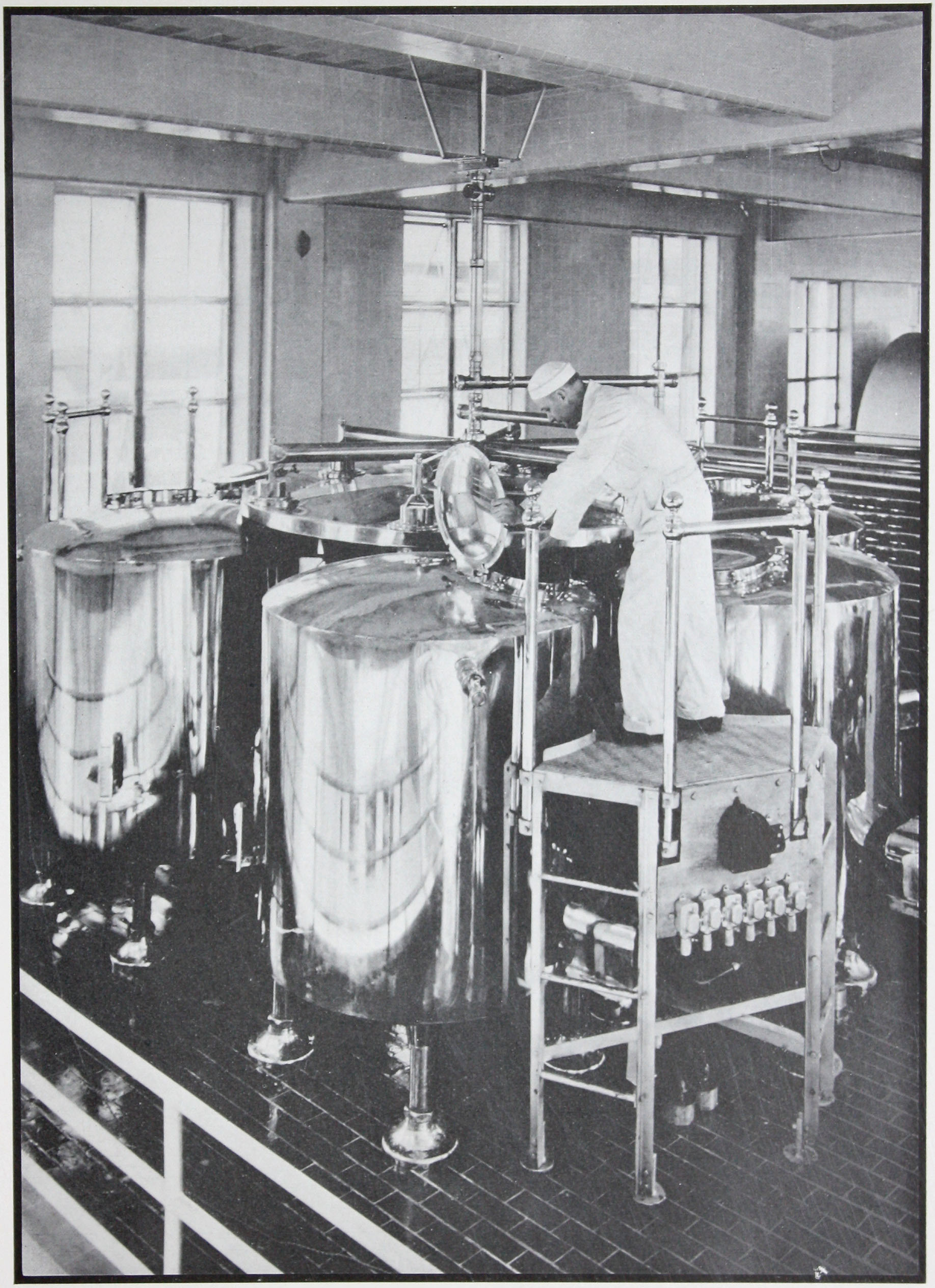
III

THE first large-scale use of Stainless Steel came in 1930. Henry Ford, breaking from the traditions of his old Model T car to introduce something smarter and more beautiful, encased the radiators of his new Model A in the glittering new rustless and stainless metal. It was a sensation. Since then the automobile industry has become one of the world's largest users of Stainless Steel. It gleams in the sun of every highway and by-road from hub caps, lamp shells, body moldings, running board trims, radiator shells and head lights. Almost may it be said, the finer the car the more Stainless Steel will be found in its construction. Rain, snow, sleet, the salt air of the sea, the murk of city atmospheres, the mud of back roads, all the punishments of travel neither harm its surface nor dim its lustre. Simply wipe it off with a wet cloth and its silvery surface is new again, outlasting the car. In automobile graveyards, amid rust and decay, it still gives defiance to weather and time and neglect.

Take apart the modern motorcar's engine, a marvel of power, speed, precision and silence, and you will find Stainless Steel the guardian of some of its most important functions. For the Stainless Prince has yet another priceless virtue. It is highly resistant to heat. Where steels of ordinary culture break down and lose strength under the fierce temperatures of combustion, "stainless" revels in its element. So you will find it adding to the fine motor's endurance and dependability in manifold heat control units, pump shafts, valves, piston rings, vital bolts and nuts. In the aviation engine where failure holds its greatest hazards the new alloy is even more fully relied upon.

New gasolines drive the modern motors of highway and skyway, new oils smooth the path of their whirling parts and new greases lend a new efficiency and ease to power. Again thank Stainless Steel, new master servant of the oil industry. It is an essential part of oil pumping equipment in the great producing fields. Literally it has made possible the present-day high quality of gasolines at today's prices, at savings of millions of dollars annually to motorists.

Modern oil refining methods demand the use of high temperatures and pressures not long ago undreamed. Tubes employed in gasoline cracking plants must withstand up to 1800 degrees of heat and terrific strains. Heretofore no metal in any form except castings could maintain its strength at such temperatures. Moreover, "sour" crudes from the mid-continent fields ate into the older alloys like rats into cheese. Life of the best cracking outfits man could devise was estimated at four to eleven weeks.



Stainless Steel automatic positive milk holder.

Miscellaneous 18–8 Chrome-Nickel Stainless Steel Castings.

Today, after more than five years of punishment under the heat and pressure and corrosive threats of gasoline cracking, tubes of Stainless Steel are still in service without the least evident impairment or loss of effectiveness. The result is that thousands of tons of "stainless" have gone into the petroleum industry to perform work that no other known alloy is fitted to do. And at the same time the stainless alloys have been found equally effective against the still higher temperatures and pressures of the hydrogenation process of cracking whereby 104 barrels of gasoline can be obtained from 100 barrels of crude. Thus the Stainless Prince stands almost as a lone guard against a dwindling oil supply, one of the primary pillars of our national security.

We use as much oil in America as all the rest of the world combined. As a fuel it is the life-blood of the Navy. The automobile industry is built on oil. Under the older methods of refining, which with some crudes produced as little as ten barrels of gasoline to the hundred, there was real reason for concern over the future sufficiency of our oil resources. That worry has been largely dissipated by the new cracking methods and the promises held out by hydrogenation. The latter, say engineers, will not only in effect expand our oil supply by many times but will make it possible, should the need arise, to convert an almost limitless amount of oil directly from coal, which we have in super-abundance. It is Stainless Steel that has made possible this prospect.

IV

EVERY arm and unit of transportation, apart from the ox-cart and the horse-drawn wagon, is leaning more and more heavily upon the stainless alloys. Led by the United States Navy progressive shipping is turning to "stainless" in the construction of its latest vessels. New uses lately introduced in railroading point to a startling revolution in this field within the next two decades.

Superior strength permits a use of much less metal, which means less weight. American naval engineers were among the first to recognize this fact. It bears upon a pressing naval problem: tonnage limits set by treaty have made weight a major factor in vessels of war.

Seeing in the findings of Brearley and Strauss the double opportunity of reducing weight without impairing fighting effectiveness and at the same time of dealing a body blow at corrosion, a more serious menace at sea than

on land, our naval engineers became perhaps the outstanding pioneers in the development of stainless alloys in America. They went into the steel industry and worked hand in hand with its experts in exhaustive tests. By rigid specifications and the thoroughness of their inspections they aided materially in raising the quality of stainless products. They helped develop new applications, which rapidly found their way into all industries and into all types of the Navy's new vessels.

Today, as a result, fuel tanks for submarines and cruisers, deck-houses and lattice-work masts, rivets in hulls, manholes in torpedo bulkheads, gun mounts, cooking utensils and refrigerators on the modern ship of war are all of Stainless Steel. By actual count in more than one hundred ways, each of them different, the American Navy relies upon "stainless." Lighter ships but ships that are stronger and more lasting have become the order of the sea.

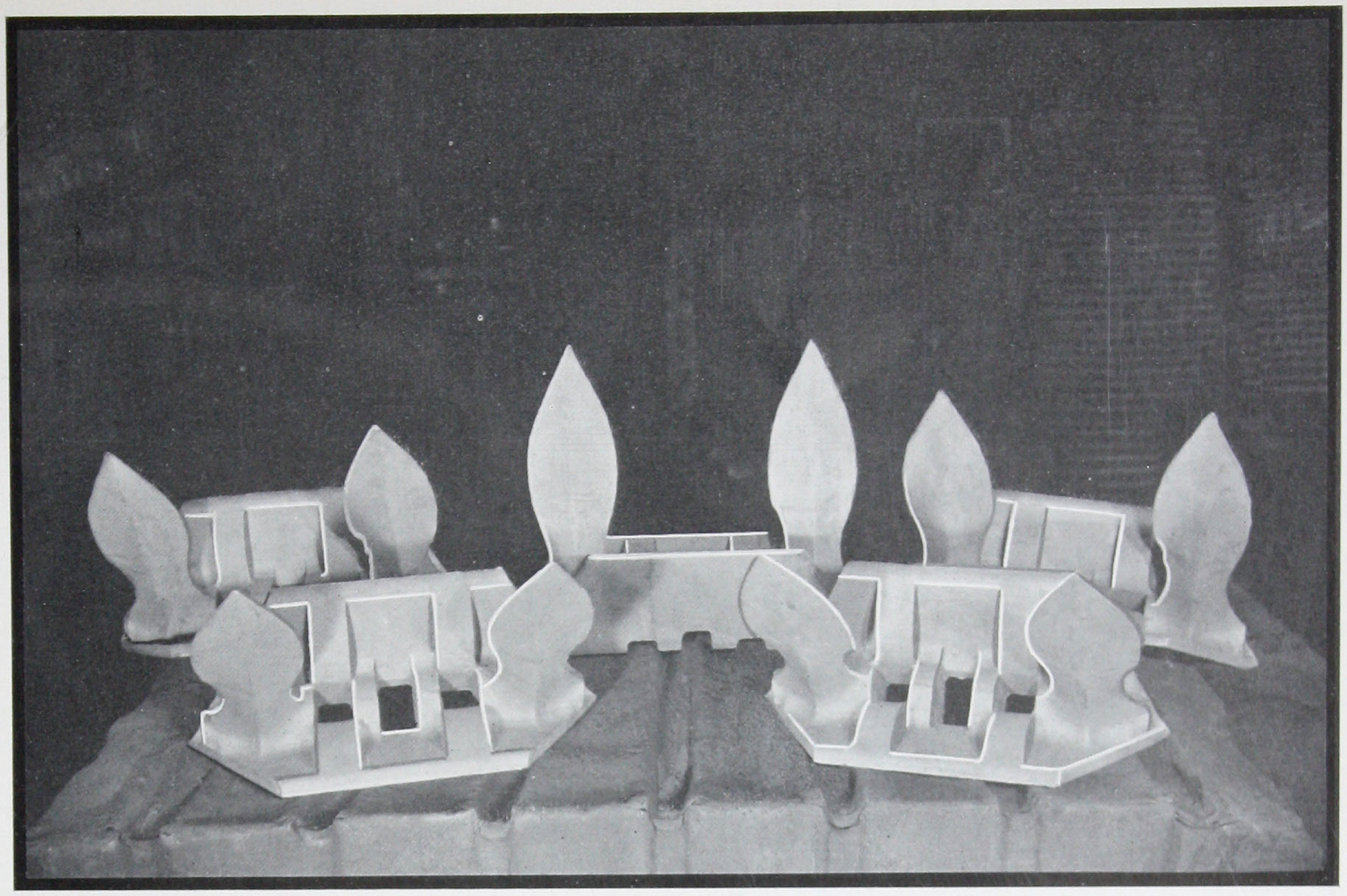
And on land, lighter and faster railroad trains, shimmering silver streaks of luxuriant travel, are flashing over the rails where once thundered alone the Iron Horse. Weight, a problem of the Navy, is likewise a railroad problem in this modern age of motor cars and airplanes. The ice cold economics of a vanishing passenger business and of freight revenues being sucked up by trucks have caused the railroads to turn hopefully to the lighter, stronger, rustless alloys. Pioneers as bold in their dreams as any Hill or Harriman of old are today welding together a new railroad empire out of ingots of Stainless Steel.

Follow the news —

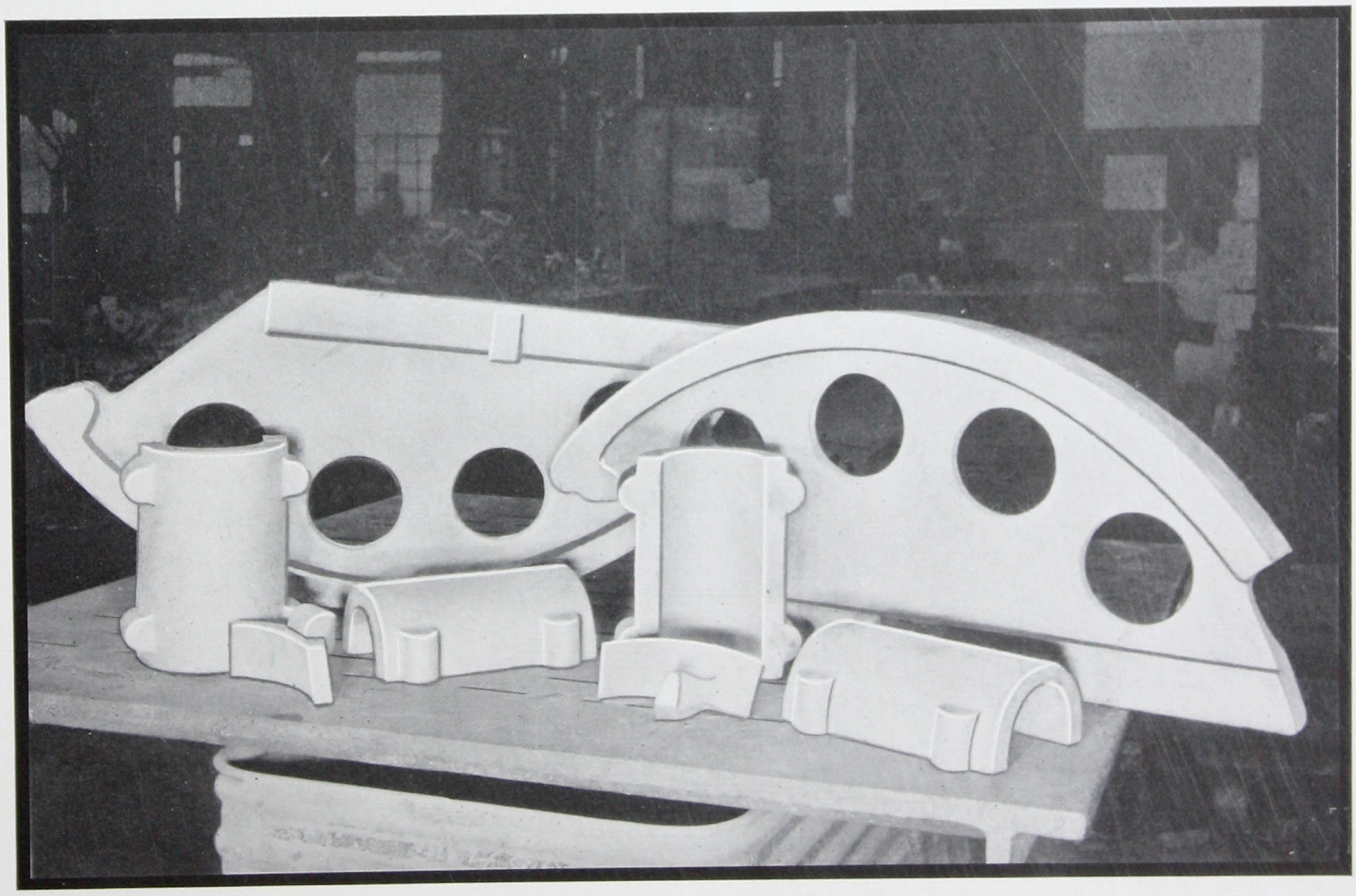
A few weeks ago a Stainless Steel train with 88 passengers aboard flashed from Philadelphia to Sarasota, Florida, and return — a distance of 2,861 miles — at a fuel cost of only $43.72. This was one-tenth of the cost of coal for a comparable steam train. It was less than the cost of operating an automobile over the same distance. Yet the 1,093 gallons of fuel oil that supplied motive power also provided air-conditioning, electric lights and refrigeration. That oil cost four cents a gallon.

If you chance to live along the line of the Burlington in the vicinity of Omaha, you may see a similar train, first of the famous *Zephyrs*, on its daily run. Its total weight is less than 219,000 pounds. It replaced two standard trains that together weighed 1,618,000 pounds or *almost eight times it.*

Only the other day two more *Zephyrs* known as The Twins went into regular service between Chicago and the Twin Cities of Minneapolis and St. Paul. Grey-topped granddads felt a thrill unknown since school days as



Hydroplane Anchor Flukes, of 18–8 Chrome-Nickel Stainless Steel. Weight, 115 lbs.



Elevating Arc, Cylinder Cap and Bracket Castings of 18–8 Chrome-Nickel Stainless Steel. Weights: Elevating Arc 325 lbs.; Cylinder Cap 50 lbs.; Bracket 9 lbs.

The First Zephyr Stainless Steel Train.

they glimpsed these speeding streaks under the western sun. But the thrill that came to railroad executives, harassed by rising costs and dwindling income, had its source in a matter-of-fact report by Coverdale & Colpitts, firm of New York consulting engineers. A paragraph of that report, based on a study of the first *Zephyr* and dated January 15, 1935, is well worth quoting. It follows:

> The material of which the train is constructed, exclusive of the engine bed, articulation castings, trucks and power plant, is in the main a cold rolled low carbon steel alloy containing 18 per cent chromium and 8 per cent nickel, known as 18-8 or stainless steel. Under all ordinary conditions it is non-corrosive. The strength of cold rolled stainless steel, such as is used in the construction of the *Zephyr*, as compared with that of other steels, is approximately as follows:

Type of Steel	*Yield Point* (*Pounds*)	*Ult. Strength* (*Pounds*)
Ordinary steel	30,000	45,000
Corten steel	55,000	70,000
Cold rolled stainless steel	120,000	150,000

In other words, here are passenger trains *3½ times* stronger than ordinary standard trains and which are faster, simpler, cleaner, quieter, and weigh only one-eighth as much as comparable equipment. The engineers' prosaic report marked a new day in railroading.

In New England, the *Flying Yankee* is blazing a stainless steel trail between Boston and Bangor, the fourth train of this type to go into service on American railroads. A stainless steel subway train is operating experimentally over B. M. T. Lines in New York City. Six big railroads are investigating *Zephyr*-type trains as built by the Edward G. Budd Manufacturing Company of Philadelphia.

So important and promising does General Motors consider this trend in railroading that its subsidiary, the Electro-Motive Corporation, is now building at Chicago a complete new plant for the large-scale manufacture of Diesel locomotives, the power units that have been breaking all records with the growing *Zephyr*-type fleet. And so important does General Motors regard the place of Stainless Steel in the modern transportation picture that such vital parts of its Diesels as crankshafts, cylinder heads, cylinder liners, connecting rods and camshafts are specified of stainless alloys. These are parts that "must not fail."

V

THROUGHOUT the construction industry the Stainless Prince is flashing an unstained sword in the face of rust. Where skyscrapers rise highest, where dams loom biggest, in places where a failure in materials means lives or irreparable losses, there "stainless" stands guard.

In vast Federal projects such as Boulder Dam, giant of giants, the stainless alloys are playing a stupendously important role. The rollers that support the massive hinges of the gates as well as the carrying mechanism itself, together with the stems that apply the moving force to the gates, are of Stainless Steel. Thus is provided a surety that as long as Boulder Dam stands its gates will open and close smoothly, free of all danger of sticking because of rust.

Along the Mississippi River wherever Federal dams are rising in the mighty effort of government engineers to check the annual menace of floods, Stainless Steel is being used to prevent failure of the water gates in emergency. In far away Egypt you will find Chrome-Nickel Stainless, 1,500 tons of it, buttressing the great mile-and-a-quarter long Assouan Dam on the River Nile, rebuilt and heightened a few years ago by the British Government.

The newest skyscrapers and the finest of new buildings of all types glisten in stainless alloys. About the time Ford was first putting "stainless" in his cars, Walter P. Chrysler was using an equally spectacular method of testifying to his faith in it. The great building bearing his name that lifts its graceful spire heavenward far above the Grand Central district in New York City is literally sheathed in Stainless Steel. Also "stainless" is used extensively in doors, store-fronts, interior lobby trim, elevators and so on. Commenting upon this, the first large employment of the metal in architecture, Frank B. Rogers, vice-president of the Chrysler Building Corporation, writes:

> "More than five years have elapsed since construction of the Chrysler Building in which we made extensive use of 18-8 Chrome-Nickel Steel. It has been satisfactory from every standpoint.
>
> "This material, in addition to all entrances, show window fronts through three floors, stair rails and lobby ornamentations, was used exclusively for the covering of the dome. Within the past six months we have had occasion to inspect the dome, and while finding it dirty from smoke and fly ash we also found that it is cleaned somewhat by the action of the elements. There was no pitting, corrosion or other deterioration apparent; the surface when wiped appeared the same as when installed.

The Tower of the Chrysler Building, New York City.

Entrance, Chrysler Building, New York City.

"Because of the accumulation of soot or dirt the dome has taken on a grayish appearance, but not as would result from the oxidation of other materials. In fact, the dome has dulled in color consistent with the aging of the masonry work of the tower, so that there exists no sharp contrast with the enameled brick and continues a very pleasing appearance.

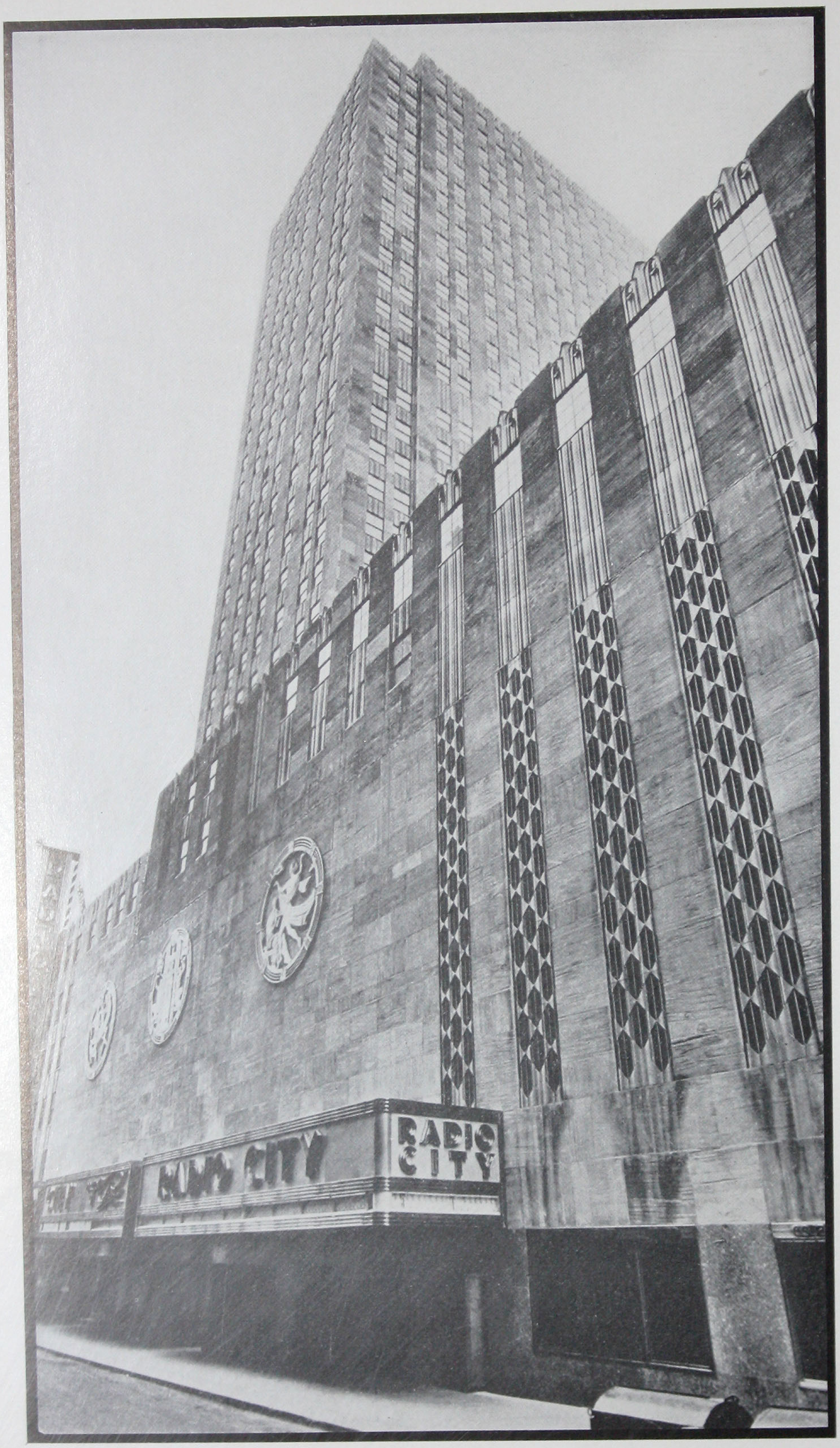
"The selection of 18-8 Chrome-Nickel Steel for entrances, show windows and interior ornamentation has demonstrated an economy, because of its easy maintenance, and although costly in initial installation has more than warranted the choice. This material does not require continual polishing as do other metals commonly used for such purposes. The only cleaning required is for the removal of dirt, and instead of having special men, metal polishers, the show-window frames and ornamentations are taken care of by the window cleaners along with the glass at the same time.

"To summarize, I should say that we are well pleased in every respect with the selection of 18-8 Chrome-Nickel Steel used in the Chrysler Building, and have recommended its use to others on numerous occasions."

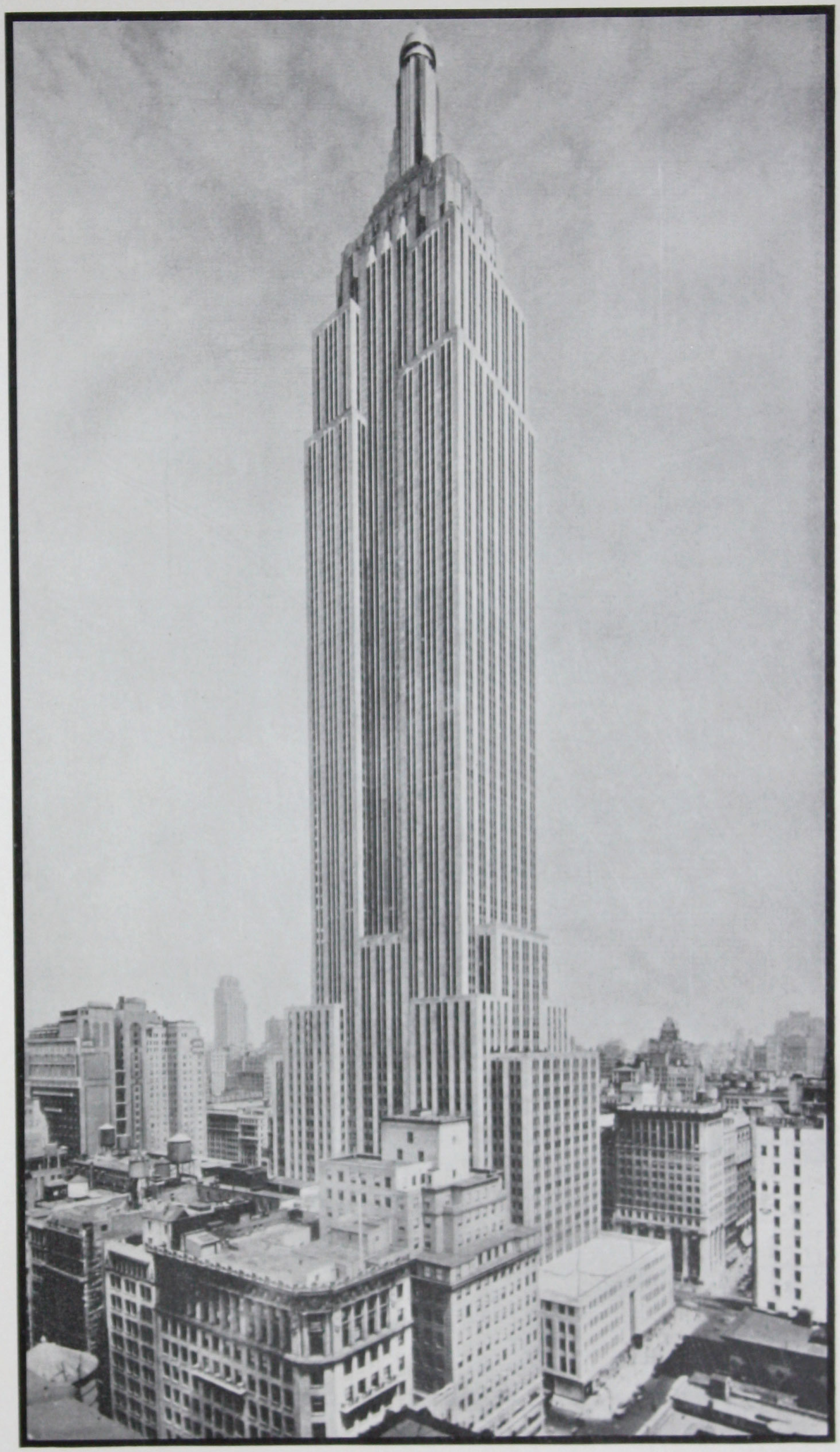
After Chrysler came the 86-story Empire State Building in New York City, the world's tallest building. Almost ten times as much Stainless Steel was used in its construction as was the case with the Chrysler Building. This was due partly to the greater size of Empire State but more to the increasing acceptance of the lighter, stronger, stainless alloys by architects. A definite trend had set in involving a radically improved construction principle — the elimination of a high percentage of the heavy stone wall section through substitution of prefabricated formed sections of Stainless Steel. Another notable example of this trend is the Syracuse Lighting Building of the Hudson Niagara Company, at Syracuse, N. Y. With the resumption of large-building activity a rapidly growing use of the new principle by architects is certain.

Steel products used for building exteriors have many architectural advantages. The rate of building with prefabricated metal is much faster than with stone or brick. There is not the usual delay necessary for the setting of cement, and large exterior surfaces are covered with a minimum of weight handled. Ease of erection is an important cost-reducing item. The "stainless" group of steels lend themselves readily to welding and riveting directly to the steel skeleton as well as with the usual clips and screws. They permit much thinner walls, which in turn create more effective floor space. They lend themselves admirably to insulation against heat and sound.

Tremendous strides are being made in building insulation that parallel the advance of Stainless Steel. Many forms of insulation, such as corkboard, fibreboard, rock wool and asbestos cements, are now available for specific



Exterior view of Radio City Music Hall, New York City.
Largest indoor theatre in the world, with a seating capacity of 6,200.



Empire State Building, New York City.

purposes. For example, a wall of steel, fibreboard and plaster only $1\,^9/_{16}$ inches thick has a resistance to heat equal to that of a solid masonry wall of $10^1/_2$ inches thickness. The steel-type wall has a weight only of $8^1/_2$ pounds per square foot as against a weight of 85 pounds per square foot in the masonry wall. And the thin steel-type wall is the stronger — it will stand before forces that will cause the masonry wall to collapse. It is the more fire-proof wall of the two. It is longer lived.

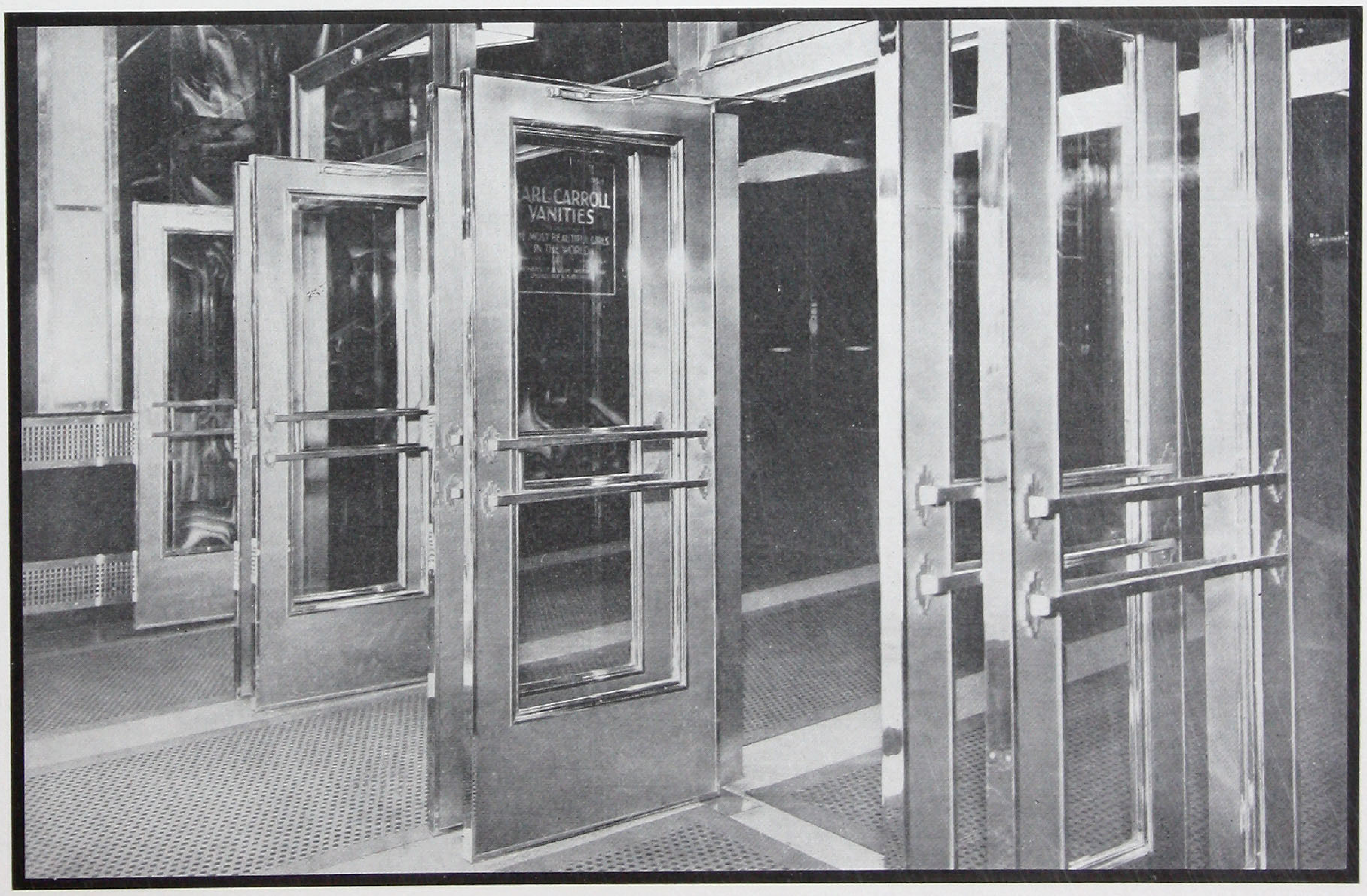
The imitation sky in the great new Fels Planetarium in Philadelphia is entirely of chrome-nickel Stainless Steel and for that reason will outlast the building.

A few years ago government inspectors discovered that the huge dome of the famous old St. Paul's Cathedral in England was showing signs of deterioration. Not only was the life of the magnificent structure threatened but the fractures in the dome constituted a serious danger to worshippers. A group of England's finest engineers studied the problem of how best the dome might be saved. Tremendous cost was involved. This, plus the irreplaceable value of the old cathedral, prompted a most exhaustive investigation of all available materials that might be used in the repair.

Tests were made both with tie rods of strong common alloy steels and with rods of 18-8 chrome-nickel stainless. The rough oxidizable surfaces of the common alloy steels readily adhered to the cement, which at first seemed to be an advantage. However, it required a maximum load only of 2.85 tons for withdrawal of the plain rods. Then bars of 18-8 were rolled and indented so that a series of flats was formed. To withdraw these bars from the hardened cement took a maximum pull of 18.88 tons.

The result is stainless steel tie rods 40 feet long, threaded at each end and four inches in diameter, are now firmly embedded in the walls of St. Paul's to tie the inner wall to the outer wall of the dome. Should haircracks ever appear in the concrete and these rods be exposed to moisture, they still will be unweakened, as they are rustless. Thus the most modern of steels is insuring the permanence of an edifice that was old when the steel industry as such was still young.

The same type steel flashes from the burnished letters of business signs, gleams softly in the furnishings of modernistic penthouses on Park Avenue, adds lightness and strength and beauty to the skyscraper's elevator, lends a new and spotless touch of luxury to the latest de luxe bathrooms. Daily, our construction industry is becoming more intimately acquainted with this alloy of endless purposes. Its fullest use here is only beginning to be dreamed.



Earl Carroll Theatre, New York City.
Doors and Marquee are of 18–8 Chrome-Nickel Seamless Steel.

Stainless Steel in the Kitchen.

VI

NO single enterprise in which we engaged during the World War has been the subject of so much controversy since as the gigantic government dam at Muscle Shoals. Now the heart of a vast electric power development in the South, the original purpose for which the mighty dam was conceived has been largely forgotten. Yet to historians Muscle Shoals stands as the symbol of one of the most dramatic efforts of the war.

Nitrogen is one of the commonest of chemical elements. It abounds in the air. However, when the World War broke all nitrogen for practical uses was obtained only from two sources, namely, the distillation of coal and from Chile saltpeter. It requires 400 tons of coal to yield one ton of nitrogen, so to all intents the world in 1914 was dependent on a single ready source of nitrogen supply — the nitrate beds of Chile. At once faraway Chile became the focal point of all military eyes.

Without nitrogen it was impossible to manufacture any explosives, agriculture would be handicapped by lack of valuable fertilizers, industry was dependent on it in various ways. The British Navy rushed to keep open the nitrate lanes to Chile and to block off the supply of Germany, in which mission it was successful. But German submarines tore into Allied shipping and German chemists startled the world with a major exploit long in preparation: they perfected a method of extracting nitrogen from the air, and the war, which might otherwise have ended, went on.

By the time we got into the conflict, in 1917, so serious had become the submarine menace and so obvious its lesson on the future economic and military security of all nations, every Great Power was building plants of one kind or another for the atmospheric fixation of nitrogen. Congress appropriated $80,000,000 for Muscle Shoals where it was planned to extract nitrogen from the air by a process requiring large amounts of cheap electric power. The war ended with Muscle Shoals unfinished and the nitrogen problem of America still unsolved.

It was too big a problem to drop, however. A reborn American chemical industry carried on. By 1922 not only had the German chemists' exploit with atmospheric nitrogen been duplicated but a vastly superior fixation process had been developed. We began producing ammonia from air, water and coal, and from ammonia we got nitric acid, the vital compound of nitrogen. Chile's monopoly was broken, a threatened German monopoly was checked, in peace and in war we stood secure in the assurance of a domestic nitrogen supply sufficient for all our needs.

A leading factor in providing this security in America was the du Pont Company, of Wilmington, Delaware. Says Dr. H. L. Maxwell, metallurgist, of this Company:

"In the synthesis of ammonia from air, coal and water considerable amounts of Stainless Steel are used economically. At certain points in the process these steels are necessary in keeping down costs. *In the oxidization of ammonia to nitric acid chrome steels of high chromium and low carbon content are absolutely indispensable.*"

The Stainless Prince thus guards not only our future security in oil but has made possible in even more positive terms our security in nitrogen, without which no modern nation could long function in peace or survive in war.

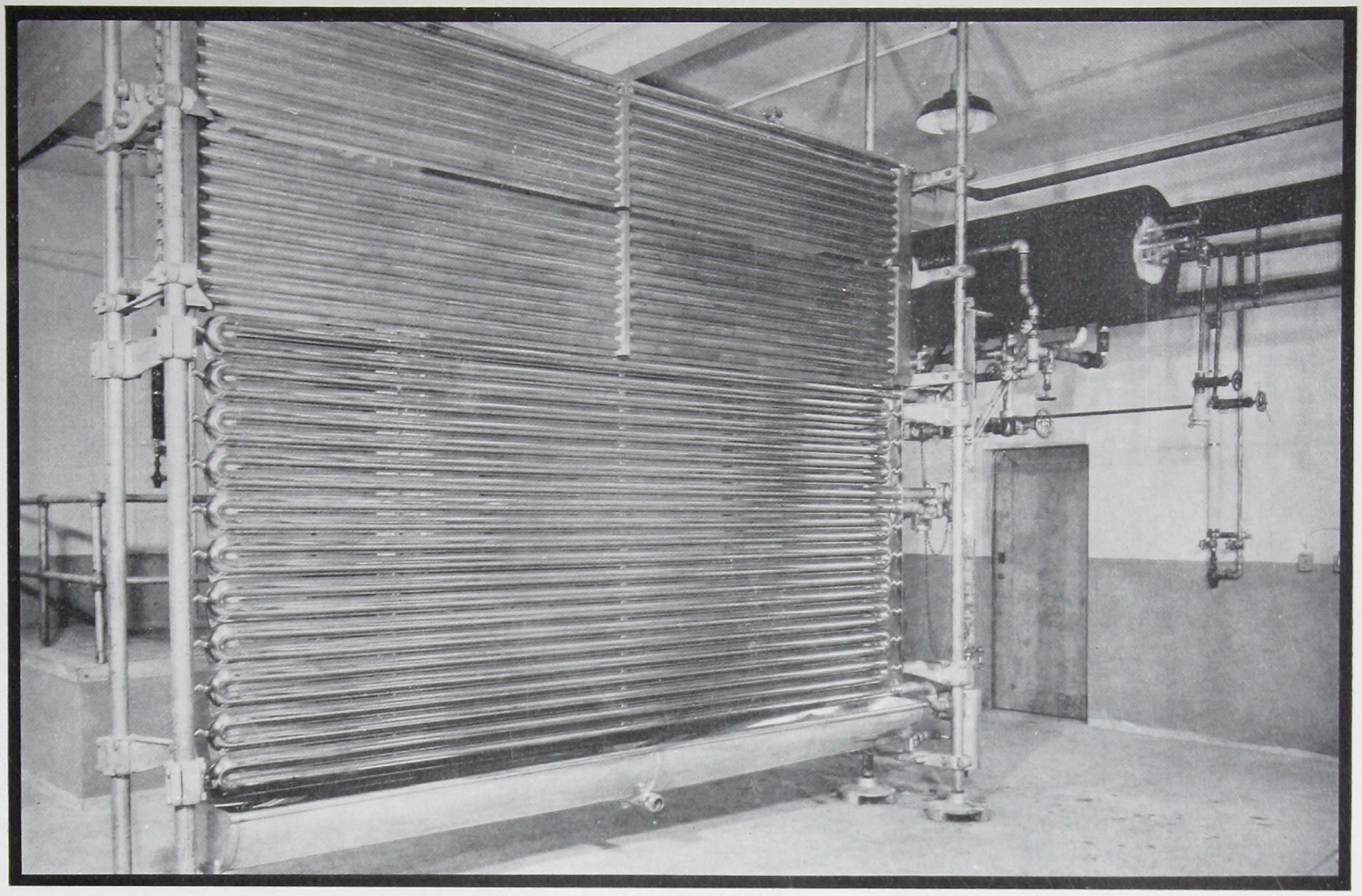
Likewise "stainless" is growing in use in the dye industry and throughout chemistry in general as a guard against impurities and because of its strength and high-temperature resisting qualities. Dr. Maxwell also says:

"The trend in dye manufacture is away from ordinary steel equipment to the stainless alloys. The latter permit greater economy of operation, are more adaptable to changes in processes, and give longer life. In the storage of many kinds of chemicals, stainless steel tanks offer a wider range of resistance to corrosive action, with the result that they have rendered invaluable service in the past few years. They make it possible to store materials for longer periods, allow a more flexible practice in buying and in disposal, which is highly important when prices are irregular. The first cost of these tanks is higher but the savings they make possible more than warrant it.

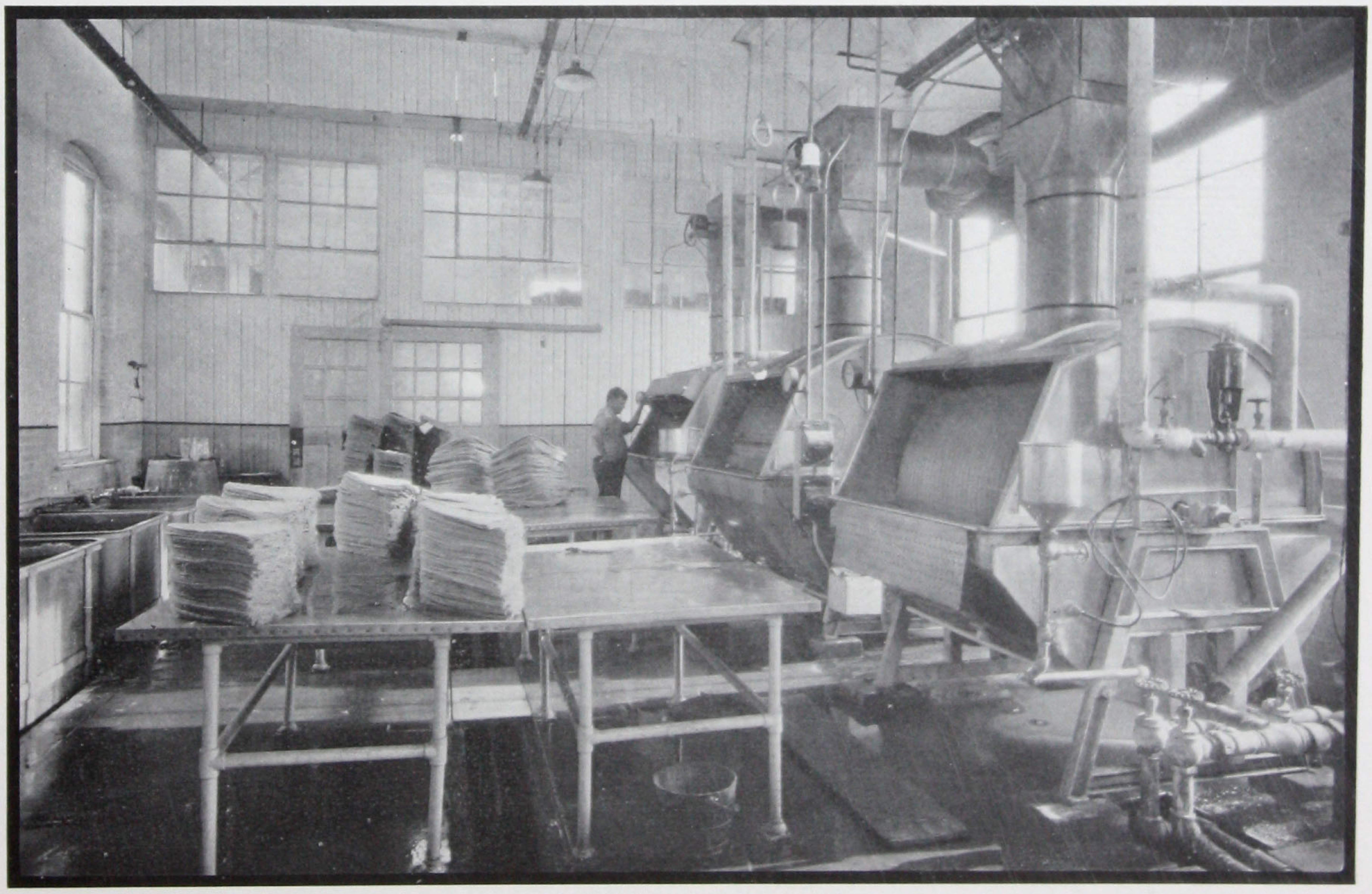
"Until recent years it was not possible to heat treat large storage tanks to develop their maximum corrosion resistance. Late developments, however, both in welding and in heat treatment have given the chemical industry a high quality of equipment not before available. Tanks as big as freight cars are now being heat treated successfully. In every respect the stainless group of steels has been so improved as to leave no question of their essential place in the chemical industry."

And as chemicals go in varying form into virtually every other industry, in their trail follows Stainless Steel fighting impurity and its twin, corrosion.

Dictate a letter — the chances are that the paper on which it will be typed owes a debt to "stainless." To what extent acids are used in the manufacture of various types of paper is not generally known, but the fact is there is hardly an industry that is more vulnerable in its various processes to attacks of rust or corrosion than the paper industry. High-grade bond papers must approach perfection. The slightest contamination or discoloration will cause a rejection of a large amount of stock. For several years now the stainless alloys have been helping solve some of paper's most difficult problems and thereby cutting thick slices off losses once thought to be unavoidable. The same is true in textiles.



Stainless Steel Ice Cream Mix Cooler.



Three Stainless Steel Rotary Dye Machines.

Stainless Steel Cafeteria Counters and Steam Tables.

The food industry's first mandate is purity, which is to say that in this modern age Stainless Steel has become an accepted necessity in the manufacture and handling of all kinds of food. Dine in any large modern hotel, restaurant or cafeteria — it is three-to-one that your meal will be brought to you from a stainless-equipped kitchen. Visit any up-to-date food plant — white-coated attendants will proudly point out that "stainless" is the only metal permitted to touch the product. Today dairymen haul their milk in "stainless" cans; it is separated and churned in "stainless"-equipped creameries; shipped by rail and truck in "stainless" tanks, and bottled with "stainless" machinery.

Meat packing is going rapidly over to the new steel that will not taint, or poison, or discolor, or wear out. "Stainless" is establishing wholly new standards of purity in the making of all such personal articles as toothpastes, shaving creams, germicides, chocolate candy.

In 1932 a Milwaukee brewer, Fred Gettelman, took a yellow pencil stub from his pocket and sketched on a piece of brown wrapping paper his idea of what a modern beer barrel should be. The result is that nowadays the finest of beers and ales are transported in kegs lined with Stainless Steel, from breweries that glitter with this prince of metals.

VII

IN the steel industry itself a new day has dawned for stainless alloys. Those of today are not the alloys of five or eight years ago. As is inevitable with any new thing the early "stainless" products were not perfect. Two pieces of equipment bought at the same time under the same specifications did not always perform alike in service. *They do today.*

Definite standards have been established and accepted throughout the steel industry. Classified information bearing on each type of stainless alloy has been developed. An indication of the dependability of present materials is the experience of the du Pont Company, a heavy and very exacting buyer of "stainless" equipment. In twelve months it found it necessary only in four cases to question standards after the most rigid of inspections.

The thousands of applications to which Stainless Steel has been put throughout industry and the thousands of carefully studied tests that have been made of it have enabled producers to compile an immense library of data on which they urge prospective users to draw. As was outlined in Chapter II, not only are there four general classes but many specific types of

Stainless Steel. Type A may be utterly unsuited to do the work of Type B, and vice versa.

As industry is becoming more generally aware of this fact, namely, that "stainless" is *not* one metal but a *class* of metals, and is calling upon producers more and more for expert advice in advance of use, the chances of failure by stainless equipment are rapidly diminishing to near zero. In the past some failures regarded as serious have often been the consequence of some such simple neglect as lack of proper lubrication methods, for example as in pump rods for which pressure lubrication is needed. Even more frequently failure would have been readily avoided by the right sort of advance testing.

"The best choice of the proper material is not always a question merely of resistance to corrosion," writes one large steel company in its catalogue. "The strength and other mechanical characteristics desired and the limitation of the available means of fabrication are frequently the deciding factors in selection between several materials all of which may present satisfactory resistance to corrosion.

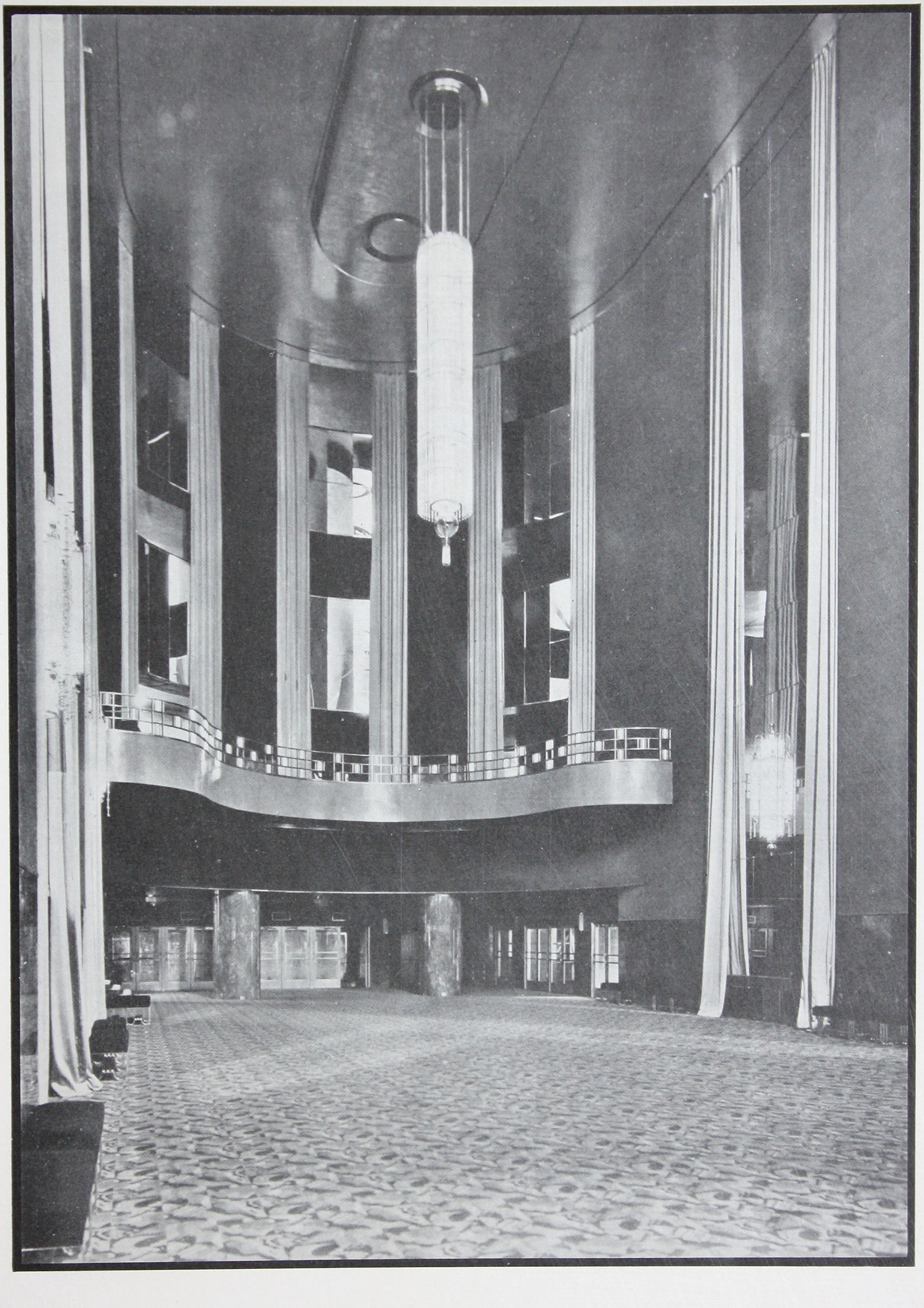
"For new and untried applications it is always advisable to conduct a test on the proposed material under actual operating conditions. In some cases where a large investment is contemplated it has been found desirable to construct a small or pilot plant. Often this may be impossible and a laboratory test, simulating as nearly as possible actual conditions, must be substituted.

"Accumulated experience in connection with installations employing the corrosion and heat resisting steels is, in many cases, sufficient to warrant definite recommendation in certain applications, but one cannot be sure that conditions which seem to be identical are identical. Therefore, the safest thing to do is to conduct tests under actual operating conditions, as far as possible."

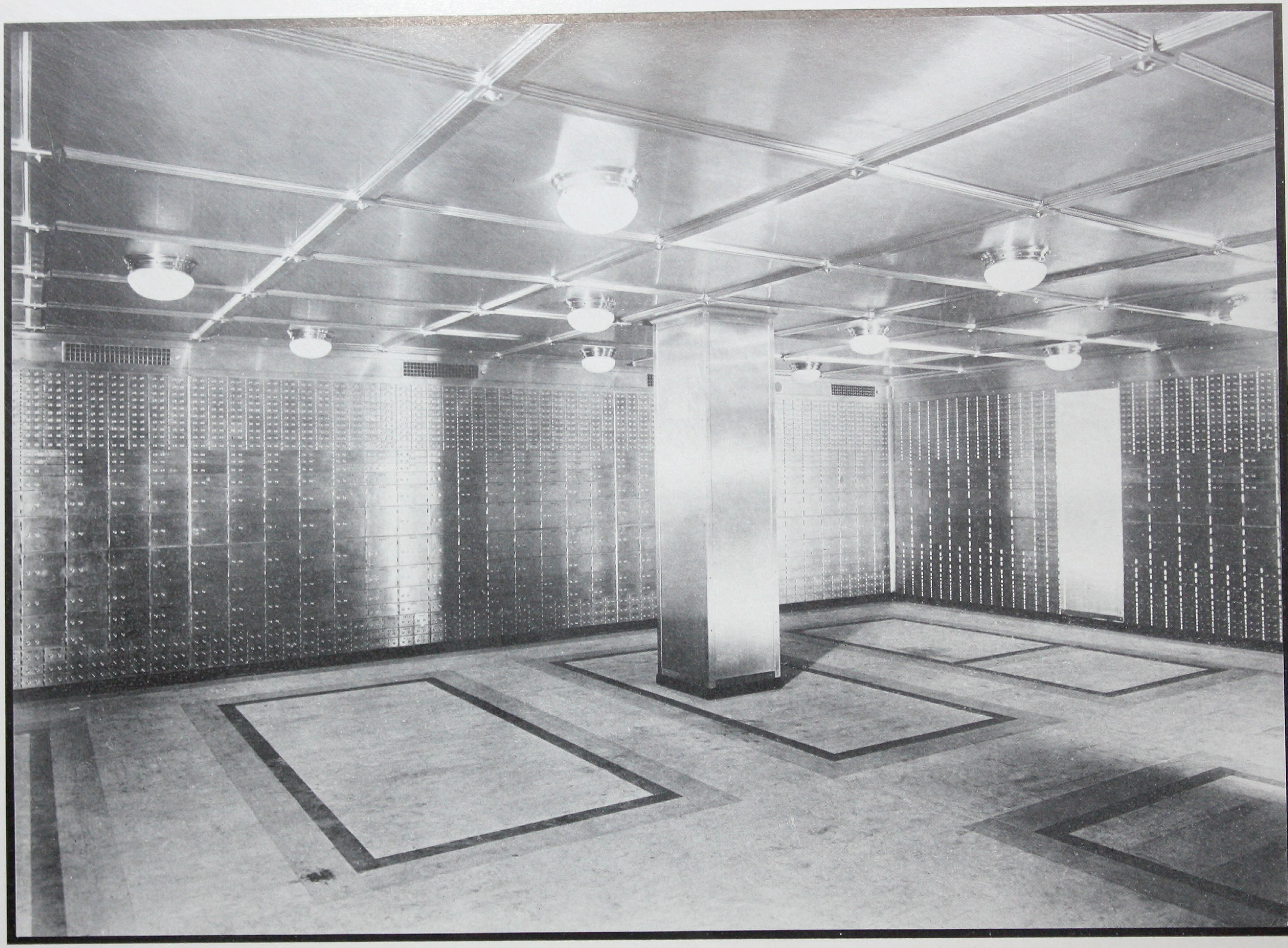
So the stainless alloys march on to glory. Long since they passed the experimental stage. Today they are here, the find of centuries, the new First Line of Defense against the ancient and omnipresent enemy, Rust. Trains racing to new records in economy in time, ships riding the ocean ways, milk trucks rumbling through the night, chemical factories drawing national security from an invisible atmosphere, food factories guarding the nation's health, refineries expanding the life of our national oil resources — over them all flies the gleaming battle pennon of the Stainless Prince of Steels.

After three years of research conducted with a group of other investigators on behalf of the Iron Alloys Committee of the Engineering Foundation of New York City, Frank A. Sisco, an authority on the subject, writes:

"The future of the steel industry lies in a turn to quality production, rather than to the quantity production of the past."



Balcony railings, Radio City Music Hall. The two lines of longitudinal intermediate rails are 18–8 Stainless Steel seamless rectangular tubing, 3/4″ x 2 1/2″.



Safe Deposit Boxes of Stainless Steel.

That turn has come in the new alloys, in the finer metals of all kinds that today are being produced, and among which Stainless Steel stands out as leader, triumphant and undisputed.

A more comprehensive list of some of its successful uses follows:

Marine

Turbines
Exhaust Stacks and Manifold for Aircraft
Torpedo Tubes
Water Turbine Shaft Sleeves
Marine Pump Plungers
Galley Refrigerators
Starboard Side-ladders
Cutlery and Tableware
Galley Dresser Tops
Motor Driven Centrifugal Pumps
Gun Director Shields
Gun Mounts
Deck Plates
Turbine Diaphragm Blades
Card Holders
Name Plates
Door Sills
Door and Hatch Fittings
Main Steam Stop Valve Seats
Valve Stems
By-Pass Valve-Seats
First State Astern Nozzles
Sheets for Wand Lights
Dough Troughs
Water Tight Manholes
Valve Discs
Sheathing for Shaft Struts
Wash Troughs and Toilet Shelves
Crews' Water Closet Troughs
Manholes in Torpedo Bulkheads
Snap Rings for Throttle Valves
Throttle Valve Seats
Manhole Covers
Escape Scuttle
Water Tight Door Bulkhead Frames
Snap Rings for Nozzle Control for H.P. Turbines
Inboard and Outboard Shaft Tubes
Valve Lock Washers
Stems for Main Steam Valves
Outer Casing Sheets
Chest Plates and Strips
Internal Boss and Cover Plates
Auxiliary in Sea Chests in Engine and Boiler Rooms
Strips for Turbine Shroud Bands
Bathroom Cabinets
Lockers for Life Jacket Stowage
Machine Gun Ammunition Service Boxes
Benches in Crews' Washrooms
Workbenches, Shelves and Table Tops
Hatch Strips
Decorative Trim
Hinges
Marine Valves
Food Containers for Life Boats

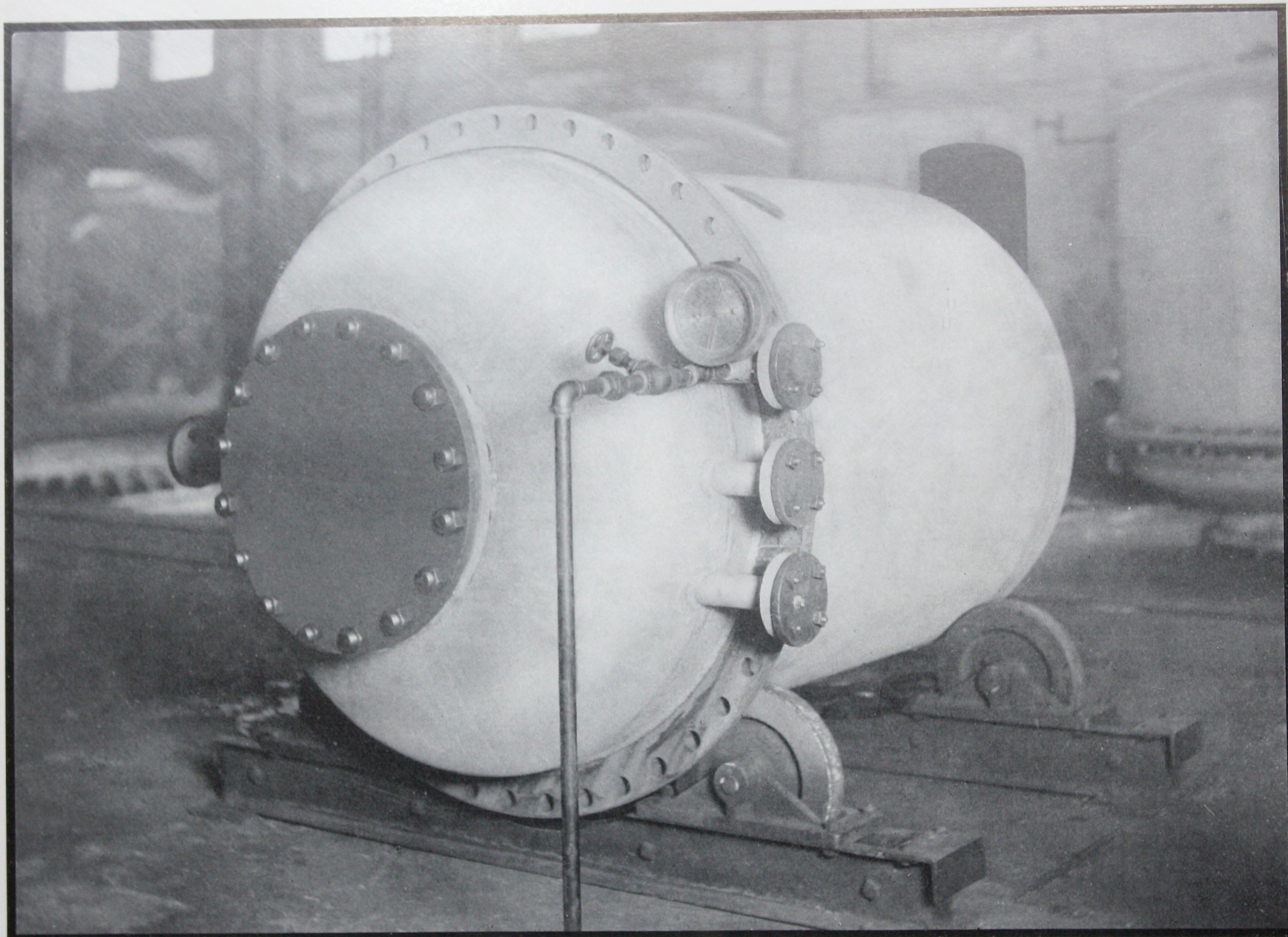
Washbowls and Waste Jars
Washer Baskets
Boiler Brick Pans
Fuel Oil Pumps
Deck Plates
Stair Treads
Mirrors and Reflectors
Welding Rods
Dishwashing Machines
Cooking Utensils
Main Condenser Pumps
Masts, Spars, Yards
Hoisting and Rotating Equipment
Evaporator Pumps
Fuel Oil Booster Pumps
Electrical Galley Equipment
Galley Dressers and Steam Tables
Furniture
Bow Driving Gear
Flues and Funnels
Handrails
Stair-rails
Kickplates
Boilers
Label Plates
Vacuum Pumps

Motor Driven Vegetable Peeling Machines
Bushings on Astern Turbine
Salinity Indicator System
Notch Blocks
Steam Shielding
Bolts, Nuts and Rivets
Hatches and Doors
Impulse Blading
Gate Valves
Wire Cloth
Insulation for Fuel Oil and Feed Water Heaters
Drain Boards
Sinks
Floor Plates
Tools
Syphon Valves for Airplanes
Diesel Generator Sets
Turret Tracks
Holding Down Cables
Wire for Aircraft
Seamless Drawn Tubing for Exhaust Stacks and Manifolds
Structural Shapes
Streamline Tie-rods
Internal Tie-rods for Aircraft Use

Aviation
Exhaust Manifolds, Pontoons, Rings, etc.
Annealing Hoods and Boxes
Architectural Trim

Outstanding Jobs:
Syracuse Lighting Bldg.
Chrysler Bldg.
Empire State Bldg.

Stainless Steel Fluted Columns.



Welded Tank of 18–8 Chrome-Nickel Stainless Steel.

Architectural Trim (*Continued*)
- Store Fronts
- Doors
- Ornaments
- Safe Deposit Boxes

Automotive
- Bright Work or Trim
- Working Parts
- Pump Shafts
- Valves, etc.
- Air Conditioning
- Equipment and Trim

Beverages
- Containers
- Tanks and Piping

Bridges
- Expansion Plates
- Trim

Baking
- Dough Mixing Machines
- Oven Parts

Chemicals
- Manufacturers of Phosphoric, Acetic and Nitric Acids
- Soda Ash, etc.

Canning Industry
- Can Making Machines
- Cans and Canning Equipment

Cement, Manufacturer of
- Calcining Drums

Confectionery Industry

Coal and Coke
- Coal Screens
- Mining Equipment

Cutlery
- Table Knives, Forks and Spoons; Pocket and Butcher Knives, etc.

Dairy

Dental

Drugs

Dams

Electrical Appliances

Fans

Films

Fire Fighting Equipment

Food Handling Equipment

Furnace Parts

Gas

Glass

Glue

Garbage Disposal

Hardware

Heat Treating Equipment

Household Novelties

Hospital Equipment
- Operating Room Appliances
- Surgical Instruments
- Hospital Kitchen Equipment

Household Appliances

Hotel and Restaurant Equipment

Incinerators

Ice Making Machinery

Jails

Jewelry

Kitchen Equipment

Laundry Machinery

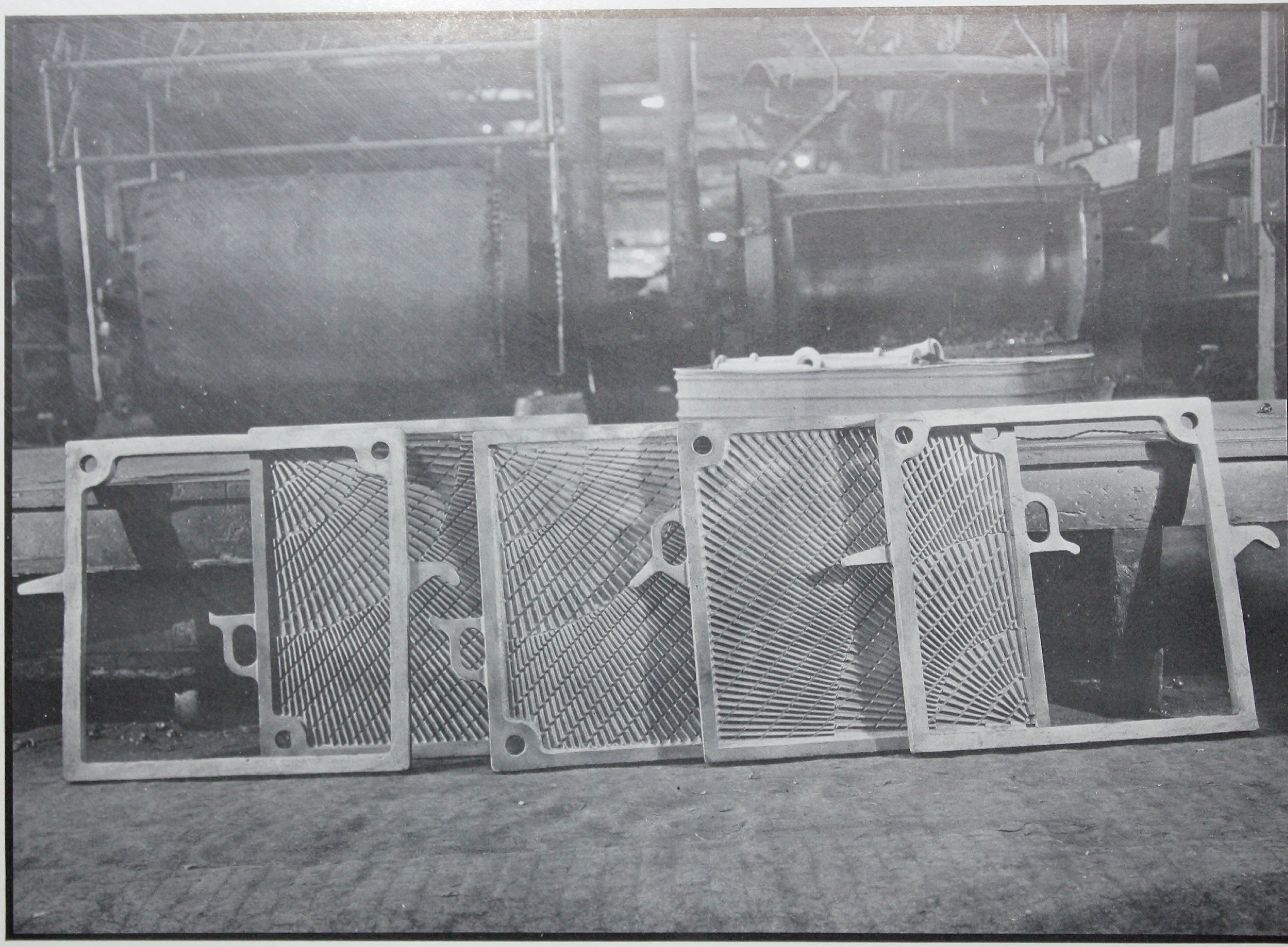
Marine
- (*See Pages 37 and 38 for Marine Uses*)

Motion Picture Industry
Mining and Metal Refining
Measure and Weighing Machinery
Meat Packing
Meters
Mortician Trays
Office Equipment
Oil Burners
Ovens
Ordnance
Paper and Pulp Industry
Power Turbines
Printing
Petroleum
Pumps
Railroads
Refrigeration
Radio

Rubber
Saws
Sporting Goods
Surgical
Salt
Steam
Shovels
Smelting
Sewage Disposal
Silk Making
Soap
Textile
Tobacco Machinery
Tubing
Turpentine
Typewriters
Utilities
Valves

Stainless Steel Exhibit.

Stainless Steel in various applications.



Filter Plates and Frames, of 18–8 Chrome-Nickel Stainless Steel. Weights 280 lbs. and 140 lbs. respectively.

LICENSEES
of
The Chemical Foundation Incorporated

Under Strauss Patents Nos. 1,316,817 and 1,339,378

Acme Steel Company
Allegheny Steel Company
Alloy Metal Wire Company, Inc.
American Chain Company, Inc.
and Associated Companies
American Manganese Steel Company
American Rolling Mill Company, The
Athenia Steel Company, The
Babcock & Wilcox Company, The
Babcock & Wilcox Tube Company, The
Baldt Anchor, Chain & Forge Corporation
Barium Steel Corporation
Bethlehem Steel Company, Inc.
Bonney-Floyd Company, The
Braeburn Alloy Steel Corporation
Cann & Saul Steel Company
Carpenter Steel Company, The
Chicago Steel Foundry Company
Colonial Steel Company
Cooper Alloy Foundry Company, The
Crane Company
Crucible Steel Casting Company, The
Crucible Steel Company of America
Delaware Alloy Forge Company
Disston & Sons, Inc., Henry

Driver-Harris Company
Duncan Foundry and Machine Works, Inc.
Duraloy Company, The
Duriron Company, Inc., The
Eastern Rolling Mill Company, The
Electric Steel Foundry
Electro-Alloys Company, The
Electro Metallurgical Company
Empire Steel Castings, Inc.
Enterprise Foundry Company
Forging and Casting Corporation
General Alloys Company
Globe Steel Tubes Company
Granite City Steel Company
Griffin Manufacturing Company
Heppenstall Company
Illinois Steel Company,
and Subsidiaries of U. S. Steel Corporation
Industrial Steel Casting Company, The
Ingersoll Steel & Disc Company
Janney Cylinder Company
Jessop Steel Company
Kropp Forge Company
Kunkel & Son, Frank
Larson & Sons, Inc., Charles E.
Latrobe Electric Steel Company
Lebanon Steel Foundry
Ludlum Steel Company
Michiana Products Corporation
Michigan Steel Casting Company
Midvale Company, The
Milwaukee Steel Foundry Company
Monarch Foundry Company
National Alloy Steel Company

National Forge and Ordnance Company

Newman-Crosby Steel Corporation

Ohio Steel Foundry Company

Otis Elevator Company

Pacific Foundry Company, Ltd.

Pennsylvania Forge Corporation

Republic Steel Corporation

Riverton Steel Company

Rustless Iron Corporation of America

Sharon Steel Hoop Company

Simonds Saw and Steel Company

Sivyer Steel Casting Company

Standard Alloy Company, Inc.

Struthers Wells-Titusville Corporation,

Titusville Forge Company Division

Superior Steel Corporation

Symington Company, The

Taylor-Wharton Iron and Steel Company

Timken Steel & Tube Company, The

Union Electric Steel Corporation

Universal Steel Company

Utility Trailer Manufacturing Company

Wallingford Steel Company, The

Warman Steel Casting Company, Ltd.

Washington Iron Works

Wehr Steel Company

Weirton Steel Company

Western Crucible Steel Casting Company

West Leechburg Steel Company

West Steel Casting Company, The

Wheeling Steel Corporation

Whitehead Metal Products Company